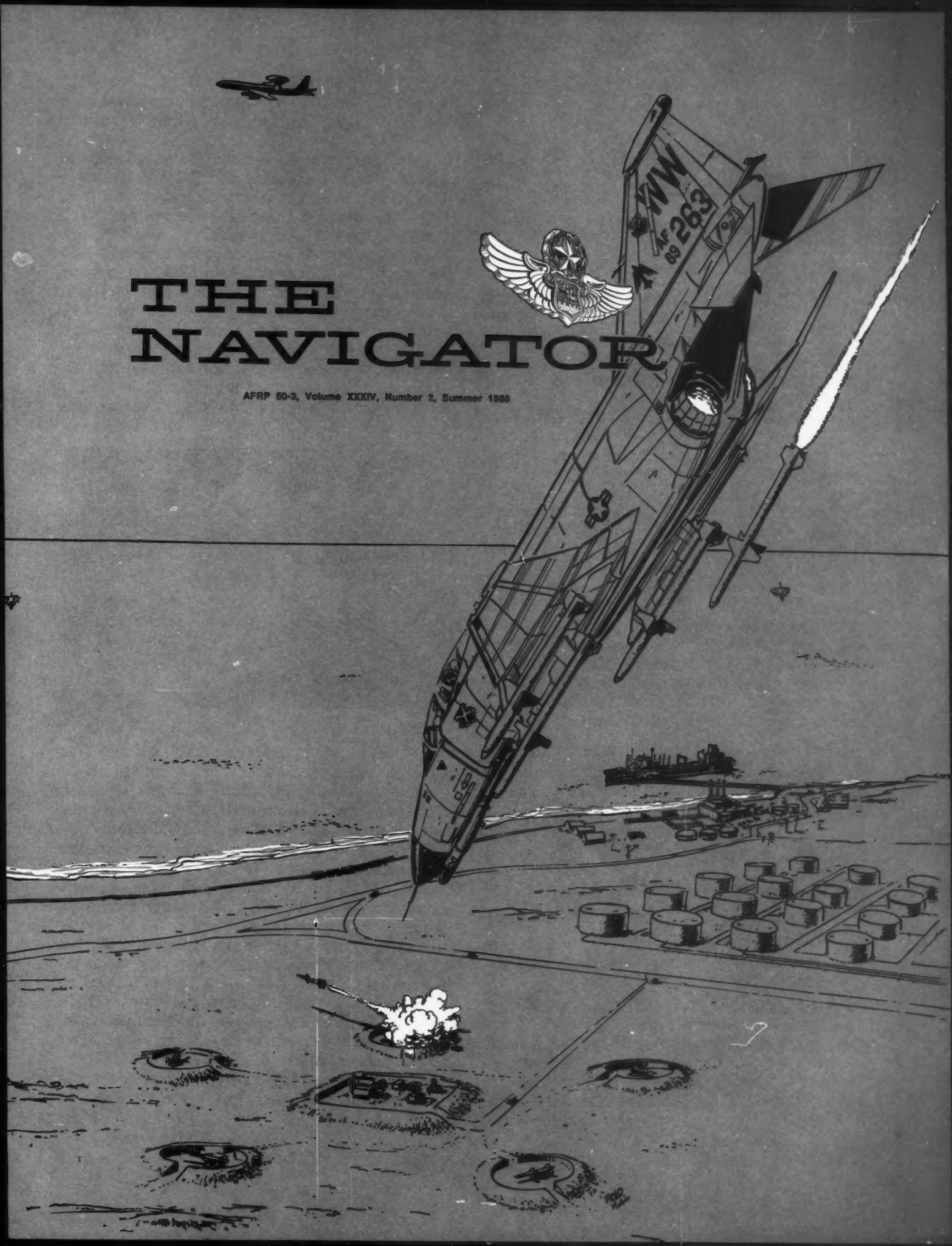


THE NAVIGATOR

AFRP 50-3, Volume XXXIV, Number 2, Summer 1988

NAV OF NOTE

BRIGADIER GENERAL WILLIAM J. PORTER

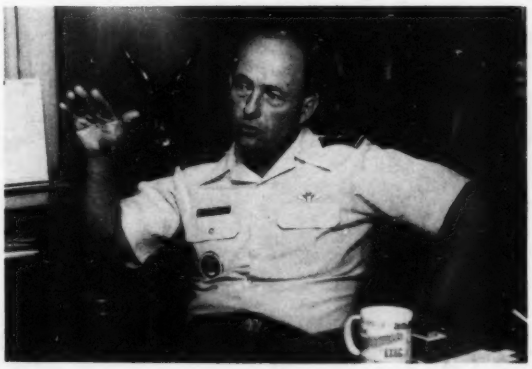
Brig Gen William J. Porter, Commander of Air Force Recruiting Service, said, "I never intended to stay in the Air Force more than five years, but it seemed to suit me. I've thoroughly enjoyed the Air Force and, 24 years later, here I am."

The Mason, Michigan, native started his military career as a cadet in the Reserve Officer Training Corps at Michigan State University. He wanted action in the air. He wanted to fly.

After Undergraduate Navigator Training in 1961 at James Connally AFB, Texas, General Porter went to McChord AFB, Washington. He amassed more than 2,800 hours in the C-124 while flying stateside and TDY to Southeast Asia. In 1966, he transitioned to the C-141 and upgraded to flight examiner. With 1,000 hours in the Starlifter, the general completed his tour at McChord in 1968.

His next assignment was to Michigan State University. Under Air Force Institute of Technology sponsorship, General Porter earned a master's degree in Applied Controllership. Then, in 1969, he went to Nakhon Phanom Royal Thai Air Force Base, Thailand, as a forward air control navigator.

After Southeast Asia, General Porter landed at the Air Force Accounting and Finance Center in Colorado. It was a mecca for comptrollers. "Rookies with no practical finance experience usually aren't assigned there. It was a tough assignment for me," conceded the general. "My being a junior officer and flyer also caused some resentment. At that time, the Joint Uniform Military Pay System (JUMPS) concept was in its infancy. Since it was new, no one knew how it should be run. A handful of us went to work on the new computerized leave and earning program. It took us nearly four years to get the whole system working smoothly. The hardest I've ever worked was on JUMPS."



His next assignment was to the National War College. After graduating, General Porter became Commander of the 450th Flying Training Squadron, one of three undergraduate navigator training squadrons at Mather AFB, California.

In 1978, as a colonel selectee, he became commander of the 3506th U.S. Air Force Recruiting Group at Mather AFB. When he took command, the Air Force was experiencing its worst recruiting year ever. Squadrons all across the nation missed their goals and so did the Air Force. Did he see his career in jeopardy? General Porter said, "No. Recruiting trends started to change. The public's anti-military attitude changed. The nation's vision changed from looking back at Vietnam to looking ahead. Our recruiting tact improved. When I left in 1981, the nation and recruiting had come through a big transition--the new vision was forward looking."

The next stop on the General's career path was Headquarters Recruiting Service. At Randolph AFB, Texas, he became vice commander. In less than two years, General Porter worked for three generals in recruiting. "They were the kind of men who let a vice commander do things. So, I was able to work the issues. We got our engineers. We built the nonprior service program. And, we steadily increased the quality of our recruits in all programs."

General Porter's next assignment was as commander of Officer Training School at Lackland AFB, Texas. At the 22-year mark in his career, he was at the promotion crossroad. Still, one more career broadening assignment was in the works.

He became chief of staff for Air Training Command at Randolph AFB in August 1983. General Porter helped author some of the major themes ATC stressed: quality of life, integrity, and back to basics. He carried those themes with him back to the world of recruiting.

In January 1985, he assumed command of Air Force Recruiting Service. One month later, he had his silver star. "I feel very humble to have been selected for the grade of general," he said. "I don't know exactly how it happened. Of course, for every person selected for general there are five equally capable, talented colonels. Much of what 'general' is based on is the jobs you've had and the opportunity to do a variety of jobs." He explained, "The more you differentiate yourself, the more you demonstrate a variety of abilities, the better the opportunity. Look at the track records of our generals. You'll find them versatile and multi-talented."

General Porter's work philosophy is simple--do the best you can in the job you're doing. "In our system, with that philosophy you'll be asked to do tougher jobs. Prove yourself and you'll be asked to do more. That goes for everyone. Senior people always look for the doers and the achievers. I'll make an observation about planned career paths. Too many people overplan, become preoccupied with the road map. Rather, they should work their present job to the limits of their potential."

In summary, the General noted an obstacle navigators often encounter--attitudes. "Don't fall prey to the second-class citizen syndrome. Don't ever believe you're second best. So much of what people are able to accomplish in life is predicated on attitude. Be positive. Do more. Be successful. It's the same in any career field. The dedicated, hard workers come to the top--that's the way our system works."

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AFRP 50-3, Volume XXXIV, Number 2, Summer 1986

Department of the Air Force

THE NAVIGATOR

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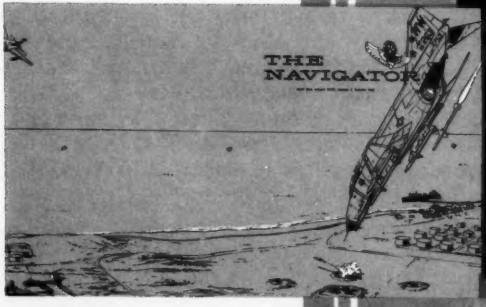


The SAM has a lock on your aircraft and you've programmed your missile to home in on his radar beam. Whose missile is going to hit first? You fire the left inboard, see the trail of smoke and break right. "SAM LAUNCH at nine!" The puff of smoke against the ground, a corkscrew trail, "Down - Break left!" The Wild Weasel mission, featured on page 16, is just one of the many specialties highlighted in this issue.

Distribution: One copy per four navigators.

navigating the GREAT WHITE BIRD

navigating the GREAT WHITE BIRD

Major Douglas L. Rudd
1 ACCS
Offutt AFB, NE

"Nav, pilot. What's our block time at Andrews?"

"Five minutes past. Touch down at two minutes past, two minutes to roll to the other end, turn around, and one minute to lower the airstairs for the pickup."

ATC interrupts with "Form 25, Heavy, do you have a frisbee on the E-4?" (This is a common question for the only military crews in the world who fly the Boeing 747.)

"Not today," replies the aircraft commander. Turning to the nav he says, "How's this groundspeed for timing?"

The nav compares his calculations with the three INSs and confirms, "Right on, if the winds hold." as the flight engineer refines the throttle setting to hold the airspeed.

So might a conversation go between the crews of the 1st Airborne Command Control Squadron (1 ACCS) after a klaxon launch from one of several operating bases in the United States. The mission today is a helicopter rendezvous to pick up the Secretary of Defense, fly an orientation flight, and then return the Secretary to Andrews for his chopper trip back to the Pentagon.

Besides the unusual mission of the 1 ACCS, we fly an unusual aircraft. The E-4B is a military version of the civilian Boeing 747-200, sometimes known as the Great White Bird. The aircraft is designated as the National Emergency Airborne Command Post (NEACP), one of three command posts which are the National Military Command Centers. The NEACP provides the National Command Authorities with a survivable command center from which they may make accurate decisions and transmit timely directions to U.S. military forces. Day-to-day operational control is exercised through Operations (J-3) of

the Organization of the Joint Chiefs of Staff. The aircraft and aircrews are assigned to the 55th Strategic Reconnaissance Wing at Offutt AFB, Nebraska.

One of the four E-4Bs was built especially for the NEACP mission by Boeing; the other three were purchased from major airlines and then modified for the command, control and communications (C^3) role. The E-4B -- the real attraction for the aircrews of the 1 ACCS -- is powered by four General Electric CF6-50E engines (each with 52,500 pounds of thrust) and weighs as much as 800,000 lbs. This aircraft can take off in 4,000 feet, cruise at 500 knots and land in as little as 4,500 feet. The standard crew consists of two pilots, one navigator, one flight engineer and one flight steward.

From the navigator point of view, the aircraft is a dream. Navigation is accomplished using one of three INSs, each capable of mixing with the others to provide the most accurate position. Additionally, the INS can be updated manually or automatically through the two Tacan systems. Future modifications include the ability to align and update through the Global Positioning Satellites. Other major navigation systems are the APQ-122 radar, dual VORs, and (believe it or not) the trusty old sextant. Future plans include replacing the APQ-122 radar with the APS-133 color weather radar. With such sophisticated equipment, navigation skills are not as necessary as nav judgment. The navigator keeps the aircraft in position to do its assigned mission, requiring extensive coordination with the communications folks in the back as well as battle staff members. The navigator is also the main 1 ACCS mission planner when Presidential support missions are scheduled. He works with the OJCS, Defense Intelligence Agency, NEACP, Marine One, and Air Force One crews in routing and timing missions plus determining air refueling support.

All of this allows the E-4B to perform its primary function as a communications platform. The communications package includes UHF FDM (AUTOVON), AUTODIN, AFSATCOM, low speed teletype over HF or AUTOVON, HF radios, VHF radios, super high frequency, secure voice, and a dual trailing wire antenna system for low frequency/very low frequency communications.

Cockpit equipment includes dual UHF, VHF, ADF, IFF, and one HF radio. Unlike most military aircraft, the E4-B has three autopilots and an autothrottle system which allows the aircraft to fly an ILS to a touchdown automatically (hands off) and an auto brake system to stop the aircraft by one of three braking modes.

E-4B crews are hand-picked for this special duty assignment. All of the navigators currently assigned have been instructors and evaluators in other aircraft--some in two other aircraft. Four of the seven assigned are majors, two are major selectees, and one is a captain. Average time in service is 12 years, with average total flight time around 3,000 hours.

Interested in being one of only seven military Boeing 747 navigators in the world? Application information can be found in AFR 36-20, paragraph 8-19. Besides an outstanding military record, applicants must be currently qualified in a multi-engine aircraft, with either tanker or receiver refueling experience.

What do navs receive as follow-on assignments? Of the last seven navs to leave the 1 ACCS, three went to staff positions at HQ SAC, one to HQ 8AF, one to AFIT, one to Space Command, and one to the 89th Military Airlift Wing. I'm sure each of these individuals will attest to the fact that being in the 1 ACCS was the highlight of their flying careers. Besides the high visibility mission, the bottom line is: "The E-4B is a dream to fly and none of us want to go back to another airplane after flying the *Great White Bird.*"

Major Rudd graduated from the University of Tennessee in 1973. After duty at Keesler AFB, he completed UNT in 1976. He was then assigned to the KC-135 at Barksdale AFB, before assignment to RAF Mildenhall in 1980. Maj Rudd currently serves at Offutt AFB.

Tuning Your

SELF-IMAGE

Captain Ronald A. Seyle
4007 CCTS
Plattsburgh AFB, NY

Many articles in this magazine address improving our skills as navigators. Some of these articles polish our skills so that we can wow our evaluators, some offer techniques to perform our jobs more efficiently, and others often explain procedures essential to flying safety. I've enjoyed them all!

In this article, I will challenge you to improve yourself in two other areas that will make you a better officer and a better navigator. I challenge you to improve your physical and mental condition. Many of your colleagues have already begun. If you delay, you may be losing ground to physically and mentally fit officers who possess the energy to aggressively attack and conquer problems vital to improving today's Air Force. Wouldn't you rather be one of them? Or are you content to sit idly by? In today's Air Force, it doesn't matter what kind of wings we wear. After all, we've had a navigator astronaut (THE NAVIGATOR, Spring 1985). What does matter is whether you can do the job. Positive attitudes and strong self-images are a must. Strengthening your physical and mental condition can improve both.

Energy is the one common attribute of successful officers. How's your energy level? Do you fly the early morning sortie, chair the staff meeting, work your additional duty, answer those write-ups, train your students, organize the squadron party, and still have the energy to jog a few miles? Or do you collapse about half-way through the staff meeting and light up another cigarette? Only you know the answer, but we both know what the answer should be.

William H. Dansforth, founder of the "I Dare You Committee," a committee dedicated to fostering youth leadership, contends that energy comes from health. I agree with him and, furthermore, I believe that almost all of us can enjoy health. Many things we want require saving for, but health, which breeds energy, is something most of us can have beginning right now. All you need to do is eat properly and start your exercise program: jogging, swimming, whatever your choice. But be serious about it. Set exercise goals, log your exercise, compare your results to your goals and keep at it. Then you too can enjoy the energy levels required for the challenging future.

I'm not challenging just overweight people. I'm challenging everyone. In a recent Associated Press article, the American Dietetic Association (ADA) points out that those who do not have an ounce of fat on their bodies may not be "in shape" at all if they do not participate in regular exercise programs. "Regular exercise," says the ADA, "reduces high blood pressure, relieves tension, works the heart muscles, and may prevent coronary arteries from becoming clogged. With regular exercise, you will be more alert, more productive, sleep better, and have more energy." Collapsing with exhaustion just when the most

energy is needed is not unique to overweight officers. Daily I see it happen to thin people as well. Your weight may have nothing to do with your energy level. How's your energy level?

Meeting your exercise goals will improve your self-image. I remember training for my first 10K race. I trained hard, but I still had doubts whether I could finish. When I did finish, my self-image went off the top of the scale. The same doubts persisted while training for my first marathon--same results. I promise you can enjoy the same pride--the price is so cheap. More important than my pride, however, is knowing that during the next stressful ORI, Global Shield, or Red Flag, someone else's nerves will snap--not mine; someone else's temper will flare--not mine; someone else's body and mind will give way under the strain--not mine. If you take your physical conditioning seriously, you too can thrive under stressful conditions. You'll be strong, fit, and full of enthusiasm. It'll be easy to call on you in the next clutch situation. Too many officers have seen success slip away because physical fatigue caused failure just when they were about to reap the rewards of a long struggle. It's all up to you. How's your energy level?

Mentally lazy people are equally repulsive! Some prefer the easy way. Old ways require no effort. New ways require work. The mentally lazy are interested in minimum effort only. I believe they are some of the poorest people on earth--constantly seeking maximum results with minimum efforts and generally finding discouragement. Rightfully, they will never experience the dignity shared by those who strive for excellence. Don't be mentally lazy! Face problems aggressively and they are half-solved. "Opportunities," says Mr. Danforth, "do not come to those who wait. They are captured by those who attack." Don't wait!

I recall the story of the Eskimo mother who killed a bear that threatened her child. A woman can't kill a bear, we say--but she did. We've all heard stories of somebody lifting a car from someone trapped beneath. Critical situations often uncover unknown capabilities within ourselves. What a shame it would be to go to our graves with so many undiscovered capabilities.

Mentally lazy people think of numerous reasons why things *CAN'T* be done--and worse, they believe them. It's up to you to find the ways things *can* be done. You will not find them if you are mentally lazy.

It's a tragedy to see an ambitious young officer striving for some goal he or she neither has the energy nor capability to achieve. It is far more tragic, however, to see the capable officer fail to succeed because he fails to uncover his own capacities.

I challenge you to improve your physical and mental condition. I think your success as an Air Force officer depends on it. Begin today!

Capt Seyle is an ROTC graduate of Auburn University. After UNT, he was assigned to the KC-135 at Travis AFB, before Barksdale AFB. Next, he flew the FB-111 at Pease AFB. Capt Seyle now serves at Plattsburgh AFB.

Major Richard H. Hobbie
328 BMS
Castle AFB, CA

On virtually every flight two problems confronting navigators are time control and centerline navigation. These problems often occur with large turns where aircraft traverse considerable distances. For example, 24 nm are needed to make a four minute 180 degree turn at 360 knots TAS. Such large turns are often made on timing trombones at en route altitudes and on low level racetracks.

Just as *heading* is the key factor in dead reckoning along a straight flight path, *bank angle* is fundamental in securing the precise time within the turn or the desired turn radius. We can examine the effects of bank angle by referring to the two tables in Figure 1, SACP 55-10, Vol II. Table I can be used to determine bank angles for making 180 degree turns where the primary consideration is time control rather than the aircraft's ground track. Table II enables determining the bank angle needed to fly a desired radius of turn for different true airspeeds to maintain centerline or rollout on the flight planned course.

Time control is the main concern in the trombones before primary entry control points and is greatly aided by making 180 degree turns that last four minutes. From Table I, Fig 1, we see that 13 degrees of bank are required for such turns at 300 knots TAS. Also note that for every 25 knot increase in airspeed over 300 knots, an additional degree of bank angle is required. This relationship suggests a rule of thumb we can designate as, "The 13 Plus 1 for Every 25 Over 300 Rule." In other words, for a 4 minute 180 degree turn, add 1 degree to 13 degrees of bank angle for every 25 knot increment the true airspeed is greater than 300 knots. Remembering this rule will eliminate the need for another addition to your "plastic brains."

Turns on most IR routes are planned with a radius of 7.5 nm. Suppose you are maintaining centerline on such a route and need to make a 90 degree turn. You're behind scheduled timing and have therefore increased the airspeed from the planned 320 knots true to 375 knots. From Table II, we see the bank angle for a 7.5 nm radius turn at 320 knots is 12 degrees, and the pilot makes the turn using this value. We also learn from Table II, however, that a 12 degree bank angle at 375 knots results in a 10 nm turn radius. Consequently, the aircraft will roll out 2.5 nm off centerline to the outside of the turn (Fig 2). (Continue this for a 180 degree turn and you'll be outside the corridor on most IR routes.)

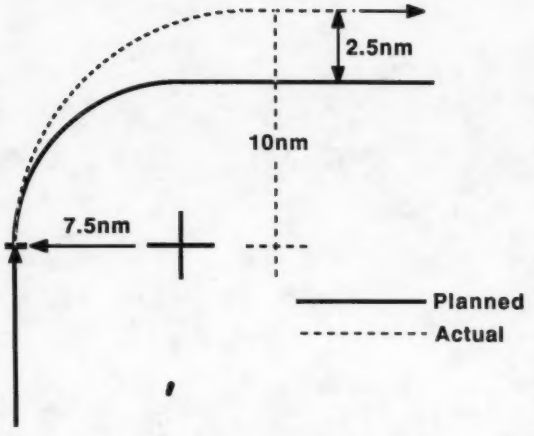


Figure 2

TABLE I

BANK ANGLE / TURN RADIUS
TIME IN MINUTES TO TURN 180°

TAS IN KNOTS	2	3	4	5	6
300	24°/3.2	17°/4.8	13°/6.4	10°/8.0	8°/ 9.5
325	26°/3.4	18°/5.2	14°/6.9	10°/8.6	8°/10.3
350	27°/3.7	19°/5.6	15°/7.4	12°/9.3	9°/11.1
375	30°/4.0	20°/6.0	16°/8.0	13°/9.9	10°/11.9
400	30°/4.2	22°/6.4	17°/ 8.5	14°/10.6	11°/12.7
425	32°/4.5	23°/6.8	18°/ 9.0	15°/11.2	12°/13.5
450	33°/4.8	24°/7.2	19°/ 9.5	15°/11.9	13°/14.3
475	35°/5.1	25°/7.6	20°/10.1	16°/12.6	14°/15.1
500	37°/5.3	26°/8.0	20°/10.6	17°/13.2	14°/15.9
525	37°/5.6	27°/8.4	20°/11.1	18°/13.9	15°/16.7

TABLE II

BANK ANGLE

TURN RADIUS IN nm	TAS IN KNOT 300	325	350	375	400	425	450	475	500	525
3	25°	28°	31°	35°	30°	42°	46°	49°	52°	54°
4	20	22	25	28	32	35	38	40	43	46
5	16	18	20	23	27	30	32	35	38	40
6	14°	16°	18°	20°	23°	25°	27°	30°	33°	35°
7	12	14	16	18	20	22	24	27	29	31
7.5 → 8	10	12	14	16	18	20	22	24	26	28
9	8°	10°	12°	14°	16°	18°	20°	22°	24°	26°
10	7	9	10	12	15	16	18	20	22	24
11	6	8	9	11	13	15	17	19	20	21
12	6°	7°	8°	10°	12°	14°	16°	18°	19°	20°
13	5	6	7	9	11	12	14	16	18	19
14	5	6	7	8	10	11	13	15	17	18
15	4°	6°	7°	8°	9°	10°	12°	14°	16°	17°
16	4	5	6	7	9	10	11	13	15	16

Figure 1

At first, most navigators believe winds cause course deviations during large turns. But let's look at some numbers. A 30 knot crosswind will cause the aircraft to deviate 1 nm from centerline in the 2 minutes required for a 90 degree turn. Thus, 75 knots of crosswind would be necessary for a 2.5 nm deviation caused solely by wind effect.

Maintaining bank angles and true airspeeds are the major factors affecting turns. The pilot's attitude indicator is calibrated for bank angles of 10, 20, 30, 60, and 90 degrees. On this instrument, it's difficult to tell the difference between 12 and 13 degrees as well as between many other such combinations. It gets even rougher with turbulence or night/IFR conditions. When large turns are accompanied by simultaneous climbs or descents, true airspeed changes proportionally to the changes in altitude for a given indicated airspeed. Moreover, making altitude restrictions rightfully takes priority over holding constant true airspeeds.

In spite of the variables created by equipment limitations, weather conditions and altitude changes, you're more likely to get the desired bank angle if you always tell the pilot the bank angle needed for each turn. The "True Airspeed Minus 20 Rule" will yield the bank angle needed for the usual 7.5 nm radius turns standard on most IR routes. Merely subtract 20 from the hundreds and tens digits of the true airspeed, ignoring the last digit. For example, a true airspeed of 350 knots (35 - 20 = 15 degrees) crosschecks with the figure obtained using Table II. In fact, the variance between this rule of thumb and Table II is within one degree for the normal range of most aircraft low altitude en route true airspeeds.

Another subject worthy of consideration is the 180 degree low level racetrack turn. These turns have some rather interesting caveats for the unwary. If you're either left or right of course, the situation usually appears to be getting better for the first half of such turns. For the first two minutes or so, the aircraft is converging to the black line, and that's usually long enough to convince you the turn is going well. If you become distracted, the next thing you know you're on the edge of the corridor regardless of the "shack" update of the system a few minutes ago (Fig 3). What can be done to avoid such situations?

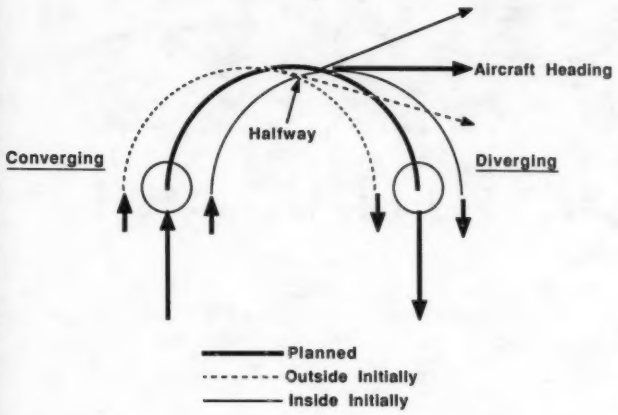


Figure 3

First of all, strive to make the flight planned turnpoint on the flight planned track. Use the "True Airspeed Minus 20 Rule" to compute the bank angle required and relay it to the pilot, "Pilot, left one six two now; use fifteen degrees of bank." Halfway through the turn, the heading marker should be about 90 degrees to the rollout true heading. If the heading marker shows the aircraft has turned less than 90 degrees at the halfway point, that is, more than 90 degrees remain before rollout, the aircraft will be outside the turn. Conversely, the aircraft will be inside the turn at rollout if these conditions are reversed. The bank angle can be adjusted at the halfway point to insure the aircraft is on centerline at the rollout point. Always recompute the bank angle using the "True Airspeed Minus 20 Rule" before making such adjustments. Recomputing the bank angle is especially useful when the airspeed is changing due to a climb or a descent.

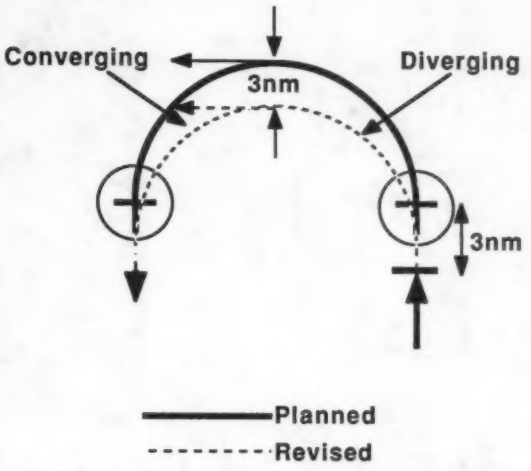


Figure 4

One more thing--if you turned short of the flight planned turnpoint for timing, then you must revise the black line accordingly. (If you turned 3 nm short, the black line is now 3 nm inside the flight planned line at the halfway point as shown in Fig 4.) The aircraft will be diverging away from the flight planned course line for the first half of the turn and will continue to be well inside it for most of the second half of the turn. This phenomenon usually results in a "Pilot, shallow the turn...Roll Out... Continue the turn.....Steepen the turn....Shallow the turn," scenario if the good old black line is not revised. Also, attempting to intercept the flight planned course while in the turn will negate some or all of the benefit of having turned early.

A graduate of the University of Oklahoma, Maj Hobbie received his ROTC commission in 1968. After UNT, NBT, and B-52 CCTS, he was assigned to Mather AFB. In 1974, he was reassigned to Wurtsmith AFB and subsequently served at Minot AFB. Maj Hobbie presently is assigned to Castle AFB.

Flying with the Best -

89 MAW SPECIAL AIR MISSION DUTY

Major Thomas P. Finn
Det 1 89 MAW
Hickam AFB, HI

Captain Jones thought he'd get an early start one morning in planning the following week's Vice Presidential around-the-world mission. When he showed up in the mission planning room at 0705, he was surprised to see Major Smith already there working on his Secretary of State trip, which was to commence two days hence.

"Well, good morning, John. I thought you finished planning your mission yesterday afternoon when you sent out the itinerary change message."

"So did I. But our crew chief was switched to a different mission last night, so I'm trying to get this crew list message change sent out first thing this morning. The stewards made minor changes to the wet and dry ice requirements as a result of the itinerary change anyway. So I can add the revised ice requirements to this crew message. How's it going for the Air Force Two planning?"

"So far, so good. We sent out the itinerary message last week. All of the embassies have acknowledged the message. Now we're waiting for most of the specific landing and overflight clearance numbers."

"What's on the agenda for today?"

"I'm going to send the computer flight plan request message after I confirm the preferred routing in FLIP for Europe and the Middle East. Today I should finish the 'canned' manual flight plans and the 1801s for all 10 legs of this mission. If you have a couple of minutes to spare, I'd appreciate your showing me how the approach and taxi time worked out for you last month when you went to Geneva."

"No problem, Tom. You know as well as I that our block-in times at destination are really important---especially for honors arrivals. I'll show you what to expect at Geneva as soon as I finish this crew change message."

"There's a lot of detailed planning to get these missions done right. But I can't get over the importance of this assignment to the 89th. I never thought I'd get to places like Casa Blanca, Mombasa, Addis Ababa, Capetown, Jakarta, Rangoon or Sydney. We take our most important leaders to the capitals of the world--London, Geneva, Moscow, Beijing, Cairo, Buenos Aires, Hong Kong, and Bangkok -- so they can carry on the affairs of governments. History is being made, and in a way, we're a small part of it. What an opportunity!"

Another day in the lives of two special air mission (SAM) navigators had thus started. The 89th Military Airlift Wing SAM navigator will spend many hours planning numerous facets of the mission to effect the safe and reliable worldwide transport of our nation's leaders. That's a lot of responsibility.

SAM navigators must thoroughly research multiple sources such as the Foreign Clearance Guide, DOD FLIP publications, and JEPPESEN information to ensure meeting all overflight and landing clearance requirements. They must compute aircraft performance data before mission departure to confirm that takeoff and landing weights will be compatible with runway weight bearing capacities and aircraft limitations, and to figure fuel requirements for each leg. They must delineate exact aircraft support requirements on arrival to provide security arrangements and aircarts, power carts, aircraft steps, etc. They also must make sure crew quarters and ground transportation will be furnished. Of course, computer flight plans must be ordered. SAM navigators accomplish all of this through teletype messages to US embassies and support agencies throughout the globe.

In flight, they perform all the duties associated with air transport navigation and are especially concerned with meeting precise arrival times at each destination. "Block times" are very important and SAM crews pride themselves on meeting their scheduled arrival times. This is measured in seconds rather than minutes. Successful block times result from detailed coordination with the pilot in planning the descent profiles, approach procedures, and taxi times.

When itinerary changes occur during the mission, the SAM navigator must be prepared to accommodate these changes. Thus, the planning process continues throughout mission completion. You can imagine the number of planning documents a SAM navigator will carry on board the aircraft to be ready for changes that may occur en route.

A good example of a major itinerary change occurred in March 1985 when Soviet Leader Konstantin Chernenko died. At the time, Vice President Bush was in Geneva while the crew for Air Force Two was preparing to take him back to Andrews AFB via a refueling stop at Shannon, Ireland. The crew had been on the road for seven days with the Vice President with stops at Khartoum, Niamey, and Bamako in Africa. They knew Mr. Bush would be traveling to Central and South America with another SAM crew three days after their arrival at Andrews.

Then the word came that the Vice President would be representing the U.S. at the Chernenko funeral. Not only would the SAM crew take him to Moscow, but after the funeral to the follow-on mission in Central and South America! The Air Force Two SAM navigators immediately began intense flight planning and drafting extensive teletype messages to secure the necessary overflight and landing clearances and to ensure meeting all support requirements to accommodate this massive itinerary change.

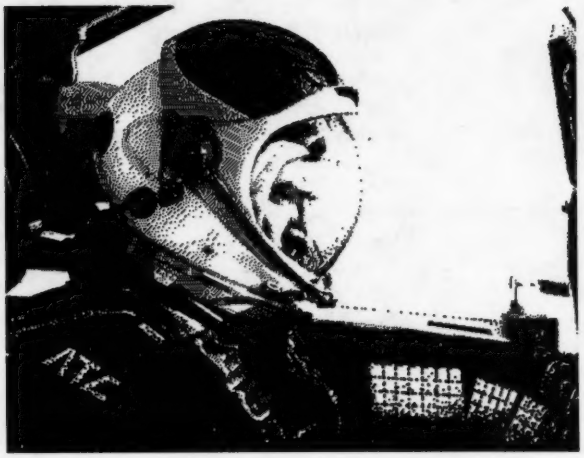
So, what started out to be an eight-day, 16,000-mile mission turned into a 15-day, 10-country trip covering more than 30,000 miles. Due to the SAM crew's proficiency and readiness, the marathon mission went like clockwork.

The 89 MAW navigators have a tremendous responsibility. The job is demanding and challenging. But it's also exciting. The navigator will literally see the world and get an on-the-job education that money can't buy. The rewards are definitely worth the efforts.

If navigator duty with the 89 MAW appeals to you, take a look at Chapter 8, AFR 36-20, on Special Duty Assignments. All of the job requirements are listed there. You must have a minimum of 2,000 flying hours as a navigator, current or previous qualification as an instructor, and at least 3 years of rated experience. If everything works out, you may soon find yourself in the 89th at either Andrews AFB or Hickam AFB as a SAM navigator. The 89 MAW at Andrews AFB has 32 SAM navigators assigned for flying the C-135s and the C-137s stationed there. You can expect as much as 100 days TDY to places you'd never imagine you'd have the opportunity to experience. You can also expect to expand your career horizons with various additional duties within the wing when you're not planning or flying the SAM mission. It is the best job you'll ever have. Period.

Maj Finn graduated from the USAF Academy in 1975 with a degree in Business Admin - istration and Management. After UNT, he was assigned to the C-130H at Dyess AFB. Next came assignment to the C-135B and C-137B/C at Andrews AFB. Maj Finn now serves at Hickam AFB.

SPECIALIZED UNDERGRADU



1986 1987 1988 1989 1990 1991
1992 1993 1994 1995 1996 1997
1998 1999 2000 2001 2002 2003
2004 2005 2006 2007 2008 2009
2010 2011 2012 2013 2014 2015

Mr Dick J. Burkard
HQ ATC/HO
Randolph AFB, TX

In 1984, to assure meeting future training challenges, the Commander, Air Training Command, set goals in two documents, *ATC 2000: A Look to the Future* and *Planning Guidance.* In essence, these goals were that every facet of the command's operation would be reviewed for the best, most efficient and most productive methodology. As a result, navigator training requirements were reviewed to assure that advanced training concepts were screened for application. The 120-day standard UNT syllabus was thoroughly studied to assure that the training would meet user command requirements. Thus began the development of "Navigator Training for the 1990s." A draft syllabus of a 135-day program for UNT was prepared. This draft added 15 training days in electronic warfare, communications, and systems to the 120-day syllabus. Navigators would receive their wings at the 135-day point and then enter one of three graduate tracks, as before. Those navigators destined for tanker, transport and bomber (TTB) aircraft would then complete 22 days of training in the Advanced Navigation (AN) course; those destined for fighter, attack and reconnaissance (FAR) aircraft would complete 25 days of training in the Tactical Navigation (TN) course; and electronic warfare officers (EWOs) would complete 92 days of electronic warfare training. HQ ATC planned to implement the 135-day syllabus in March 1986, and the required funds had been appropriated.

By mid-1984, training requirements for TAC's dual-role F-15E aircraft came under study. Training officials found the weapon systems officer (WSO) requirements for this aircraft were very demanding. They concluded that even with the approved 135-day syllabus, the Tactical Navigation course "will have to graduate highly proficient low level navigators capable of performing numerous tasks at one time."

To assure "highly proficient" navigators were graduated for F-15E WSOs, the HQ ATC Navigator Training Division recommended developing a track system at UNT to give more training in the Tac Nav Course. Under the present system, the graduates are only introduced to the basics of low level navigation. Tac Nav must be emphasized so the graduate is not only an expert in low level navigation but also has maximum situational and aircraft awareness.

By August 1984, the HQ ATC staff favored an even more specialized navigator track training program for the 1990s. Headquarters navigator training officials held planning meetings at Mather to study the requirements for a "track" system and how those requirements corresponded with the approved 135-day syllabus program. As a result of these meetings, the 135-day syllabus was implemented with UNT class 87-01 in March 1986, and work began on a track system for FY 1989-90.

After reviewing the proposed Specialized Undergraduate Navigator Training (SUNT)

ATE NAVIGATOR TRAINING: PLANNING AHEAD

program, the planning meeting agreements were briefed to the HQ ATC Deputy Chief of Staff for Operations. The Deputy then directed that if manpower and budget considerations allowed, SUNT should be implemented in 1986 rather than the 135-day syllabus. He also directed that ATC training officials seek support from the other major commands.

By March 1985, Specialized Undergraduate Navigator Training for the 1990s was a well developed concept. Training officials found that SUNT was efficient and could be achieved with the current manpower, budget and aircraft. The commands--SAC, TAC, and MAC--fully supported the program. SUNT appeared to be a better way to produce a better trained navigator at no additional cost. In fact, an annual recurring savings of approximately $1.8 million was possible. On 20 March 1985, General Iosue, HQ ATC Commander, approved the implementation of SUNT saying: "It looks good. If we don't need any more money or manpower, let's do it while the iron is hot." With this decision, work on the 135-day syllabus ended and all attention was directed toward implementing SUNT.

A "straw-man" syllabus for SUNT was developed by Mather training officials during May 1985. Using three specific tracks in UNT would better prepare graduates for follow-on training in their specific aircraft assignments. Under SUNT, all navigator candidates would receive a 65-day common core training course. Depending on the individual aircraft preference, student performance, and aircraft availability, the students then would be programmed into one of three training tracks: FAR (95 training days), TTB (95 training days), or Electronic Warfare Training (EWT) (107 training days). At the end of track training, navigator students would have completed 160 days (172 days for EWT) of undergraduate navigator training before receiving their wings. Under the current system, students receive their wings at the completion of UNT, before taking any graduate training. Any student who fails the graduate training is processed under the Air Force mandated Flying Evaluation Board. With SUNT, the students complete all of their track training before receiving their wings; therefore, students unable to progress will be eliminated through the faculty board process before receiving an aeronautical rating.

In mid-1985, the Course Training Standards (CTS) Conference--composed of representatives from MAC, SAC, TAC, ARF, German Air Force, Italian Air Force, and ATC--reviewed the curricula for the specialized track and core courses. At this conference, general agreement on SUNT was obtained and, with minor changes, the CTSs for the courses were approved. Recommendations, which reflected some earlier HQ SAC concerns about the amount of electronic warfare training and aircraft sorties, were adopted and reflected in the electronic warfare portion of SUNT.

Once the CTSs were approved, extensive work began on the syllabuses and courseware. This work was interrupted by the unprogrammed loss of 13 T-37 aircraft to Tactical Air Command. This loss of resources required a second "mini" CTS conference.

The "mini" CTS conference, held early this year, resulted in minor adjustments to the core and FAR track syllabuses. Once these were incorporated, courseware development resumed at "full speed."

What began as a look to the future in 1984 resulted in a revoluntary training program for all navigators. SUNT began on 15 July 1986 when the first CORE class was welcomed. Once again the ATC navigators will "Show the Way" to the future.

After enlisting in the Air Force in 1953, Mr Burkard graduated from the University of Omaha in 1964 and received his commission via OTS. In 1983, he retired as a Lt Col, and then became a historian with the Air Force Communications Command. Mr Burkard now serves as a historian in the History and Research Office at Randolph AFB.

SAM Suppression - Our

Captain Dennis E. Robinson
USAFTAWC/EWEE
Eglin AFB, FL

Wezel 01 and 02 are two F-4G Wild Weasels supporting a package of fighters on a deep interdiction mission. Ted and Dennis are the pilot and electronic warfare officer (EWO) in Wezel 01. Quotations enclose radio transmissions.

Dennis: Well, Ted, the package should be about two minutes from the FEBA (forward edge of the battle area) now. Let's get something airborne.

Ted: Roger. What do we have up?

Dennis: Two 6s, an 8, and a couple of 4s deep. Let's take out the 6s. Select your right inboard (AGM-45 Shrike missile).

Ted: Roger. Right inboard selected. What's the range to the 6?

Dennis: 18. Come right to 90°.

Ted: Coming right. "Wezel 01 attacking at 6."

Dennis: Take it down, Ted. He's tracking us.

Ted: Going to 100 feet. "Wezel 02 defending 6." "Wezel 01 tally-ho missile right 1 o'clock--it's on you 2."

Dennis: Let's give 'em something to think about--pull 30 and shoot! "Wezel 01, shotgun 6--comin' off right."

Ted: Missile's away--you see 2?

Dennis: He's at 4 o'clock--guess he survived. Ted, we've got an 8 launching! Come hard right, put him on the beam--chaff! "Wezel 01 defending 8."

Dennis: Red hot 2! Standby for a break turn--chaff comin' out again--break left! It's still guiding! PULL!! There it goes, egress west--let's go home.

That's what combat might be like in the F-4G. At least, that's about the way it is at Green Flag (except for the missile launches). Being an EWO in the Wild Weasel is challenging and exciting, but perhaps many of you don't know what an EWO does (or is). Let me see if I can fill you in.

What do you think of when someone says EWO? Somebody who listens to beeps and squeaks from his Walkman while jogging? Someone who parks next to the GCA radar antenna on Friday nights? What about a Wild Weasel EWO? Probably you think of someone who is all of the above. Actually, a Wild Weasel EWO really is a graduate of UNT/EWT; usually an experienced fighter WSO, and a graduate of the Wild Weasel training course at George AFB CA.

If this sounds like considerable training and qualifications, it is. The F-4G EWO is the critical part of a demanding mission. He must be familiar with the frequency and capabilities of all surface-to-air missiles, antiaircraft artillery, and airborne intercept radars (both enemy and allied). He must continually strive to know enough about the enemy to go head-to-head and survive.

The F-4G aircraft and its equipment and ordnance are the EWO's tools. The APR-38 Radar Homing and Warning Receiver tells him what threats are engaging him and where they are located. With that information, he can deliver a variety of ordnance.

The AGM-45 Shrike series of missiles is the main Wild Weasel ordnance. There are many different types, but they all home on radar energy and have the same basic limitations. Limited to fairly short range, they must be pointed at the target to guide. The new high speed antiradiation missile (HARM) is much more capable. It has a longer range, can turn after firing, and is a very fast

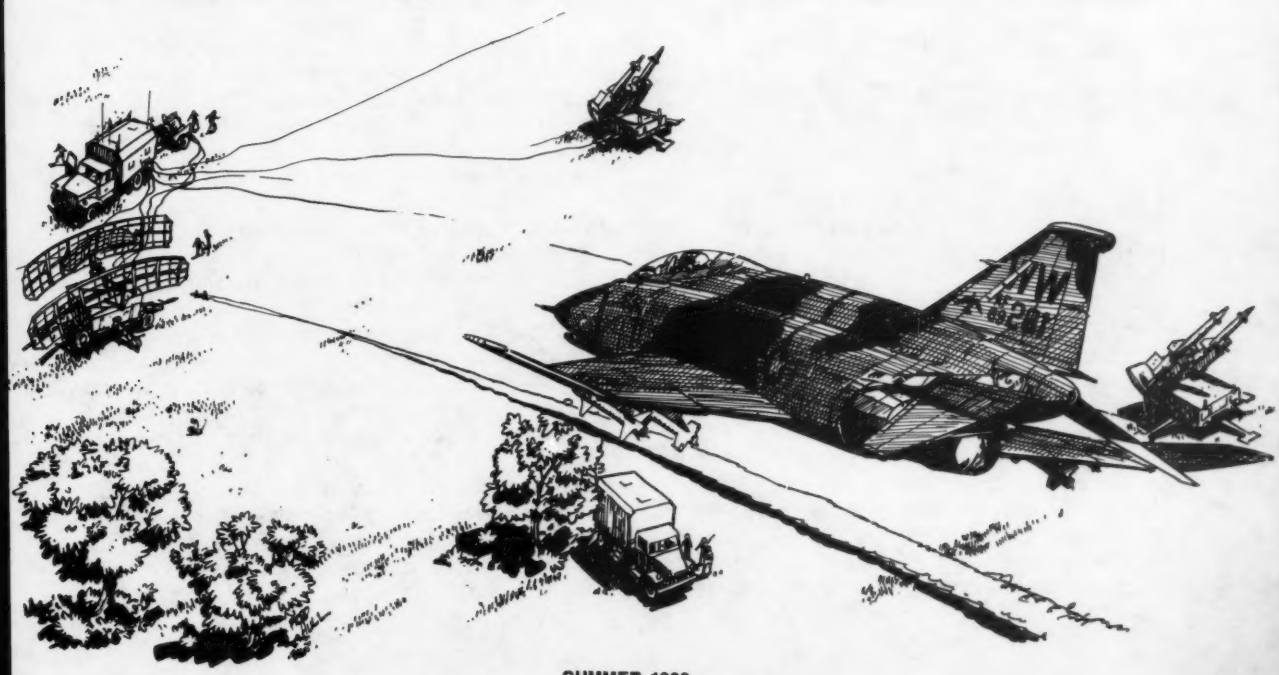
Profession

missile. HARMs are just entering the inventory, however, and are yet to be combat proven. For self-defense, the F-4G has its radar and radar-guided AIM-7 missiles and AIM-9 infrared-guided missiles. When the F-4E was modified, the gun was removed to make room for the APR-38 equipment. The F-4G also carries ALE-40 chaff and flare dispensers and the ALQ-119 jamming pod.

All of these tools enable the Wild Weasel aircrew to carry out the defense suppression mission. Wild Weasels try to make the FEBA more penetrable by diverting the radar operators' attention off the strike package and onto their own survival. We do it by making our presence known--letting the operators know that if they keep their radar on the air, they may get a missile stuffed down it. Simply stated, we play cat and mouse with the threats. We might penetrate with a strike package, operate autonomously, or tangent with some other "killer" aircraft. In any of these cases, the mission is always busy, dangerous, and exciting.

What do you think of a Weasel EWO now? Whatever you think, the EWO is ultimately responsible for the success of the Wild Weasel mission. He must analyze the threat array, select targets for attack, pick the attack axis and egress route, and direct maneuvers as necessary to survive. All this to try to permit the strike package to penetrate unharmed. Sound like a suicide mission? It could be, but we hope our daily training will prepare us for combat survival. The "weasel" attitude was recently displayed by one of our instructors when he answered the phone at Green Flag, "563d Wild Weasels. Can we kill something for you?"

A graduate of the University of Central Florida in 1978, Capt Robinson was commissioned via ROTC. He completed UNT, EWOT and F-4 training before assignment in 1980 to Torrejon AB, Spain. In 1983, he was reassigned to the F-4D at George AFB. Capt Robinson now serves at Eglin AFB.



Major D. Scott Hamilton
451 FTS
Mather AFB, CA

Many people have claimed their assignment is the "best kept secret in the Air Force." While I won't dispute their claim, Detachment 1 of the 89th Military Airlift Wing, located over 5,000 miles from its parent unit at Andrews AFB, could also be competitive for such a title. Situated near Pearl Harbor at Hickam AFB, Hawaii, Det 1 certainly has a desirable setting. Climate alone may not make an assignment enjoyable, but when coupled with a mission of transporting VIPs, the chances improve significantly.

The article on page 12 discusses the role of the special air mission (SAM) navigator from the perspective of the 1st Military Airlift Squadron (MAS) at Andrews AFB. The notoriety of the blue and white C-135B and VC-137 aircraft highlighted with "United States of America" is often reinforced through frequent appearances on the nightly news. But how many have ever noticed one of those blue and white C-135s with a white (rather than black) nose? The white nose identifies the C-135C as a Special Missions Pacific aircraft assigned to Det 1.

Formed in 1974, Det 1 uses two C-135Cs--previously weather aircraft--which have been modified to a VIP configuration. The small detachment has only 33 aircrew members with 4 or 5 navigators in addition to pilots, flight engineers, communications systems operators (CSO) and air passenger specialists (APS). Flight crews are augmented with crew chiefs from the 15th Air Base Wing maintenance unit at Hickam AFB. Because of its size, unit members work together more closely developing a true esprit de corps.

While there are many similarities between the units at Hickam and Andrews, there are also subtle (albeit significant) differences. Perhaps the most important difference is the mission tasking of the aircraft and aircrews. Tasked by the Office

of the Vice Chief of Staff of the Air Force, the 1 MAS aircraft and crews at Andrews support the travel requirements of high level dignitaries. HQ PACAF also tasks Det 1 to meet the travel needs of the Commander-in-Chief Pacific (CINCPAC), Commander-in-Chief Pacific Air Forces (CINCPACAF) and other high level military and civilian leaders including the Commander-in-Chief United Nations Command (CINCUNC) in Korea.

You may be confused about exactly who Det 1 navigators work for. That's not unusual, since they're flying a MAC aircraft scheduled by PACAF/DOU in direct support of an Air Force general, a Navy admiral, and an Army general stationed in Korea (among others). Although located in 22 AF territory, chain of command runs through 21 AF because of the parent unit at Andrews AFB. At times a score card is almost needed to determine the players, especially when the VIP has members of other services traveling with him (as CINCPAC always does).

Working with many senior officers, navigators assigned to Special Missions Pacific learn diplomacy and flexibility in meeting changing schedules. Just as is true for the 1 MAS, timeliness and precision are essential for Det 1. The standards of safety, passenger comfort and reliability (in that order) apply equally to both units. Det 1 mission requirements are also similar to those at the 1 MAS. These include researching flight information publications and the Foreign Clearance Guide, flight and fuel planning, performance calculations, sending messages, tracking clearances, arranging accommodations and crew transportation, and (of course) completing currency/proficiency requirements.

Aside from flying in Class A uniforms with wheel hats instead of flight caps, what differentiates the SAM navigator's job from that of any other MAC-type navigator? In a word, variety. Because virtually every mission is unique, adapting to ever-changing circumstances replaces job routines. Needless to say, you'll seldom hear a SAM navigator complain of monotony. Furthermore, if a mission runs according to the original itinerary, it is an exception. More often, change is the rule due to the dynamics of the environment that our nation's leaders must contend with daily. The navigator must be flexible. This can mean personally visiting the U.S. embassy, meeting with the air attache, and arranging for new clearances, etc, at the communications center.

An example of this transitory nature of Special Missions Pacific may help to illustrate. On one occasion, the Commander-in-Chief Pacific Forces was returning from a ten-day mission to eastern Africa, having completed stops in Nairobi and Mombassa, Kenya, Mogadishu, Somalia, and Muscat, Oman. Following a 10-hour flight from Oman, the mission was scheduled to stay at Clark AB, Philippines for two days before returning to Hickam AFB. Upon arrival at Clark AB, the crew learned it would be best to depart sooner since a typhoon was headed for the Philippine Islands. Working with the Admiral's aide, the CINCPAC's schedule was revised to limit the stop to 10 hours. The navigator and aircraft commander then coordinated the itinerary change by message through the Clark AB Command Post to advise officials at Clark AB, Subic Bay Naval Base (where the Admiral had been scheduled for a brief visit), and the PACAF Command Post. Through this coordination, ground transportation requirements from Hickam AFB to the CINCPAC's headquarters were rearranged, customs officials learned of the new arrival time, protocol offices at both Hickam and Clark revised their schedules, and all the other itinerary change details were worked out. Because the CINCPAC maintains operational control of his command even when away from home station, communications procedures were especially critical. Satellite links to aircraft teletype and voice communications systems provided both instant and secure capabilities to enable the Admiral to effectively execute his command. Was this a typical mission? Yes and no. Like many, this one was especially rewarding to the crew, since they personally contributed to a successful endeavor.

Although all missions differ, not all are exciting. On another CINCPAC mission, the Admiral visited Diego Garcia to support the personnel serving in that remote location. As a result, the crew spent Christmas Day on the island before returning to Hawaii for a second Christmas (after crossing the international date line). Like all military members, Special Missions Pacific crew members work their share of holidays, perhaps even more than their share. Admirals and general officers often travel over weekends (particularly three-day weekends), so they aren't away from their offices during workdays.

Due to the sensitive nature of Special Missions Pacific, precision and punctuality are essential to

mission success. The navigator's role in managing the message traffic makes him the critical link in this system. Thorough coordination with the other crew members is also a necessary ingredient for success. Working with pilots, the navigator plans descent profiles and taxi routes, completes flight plans (both the DD Form 1801 and a manual flight plan in case CFP support is not available), and reviews clearance and accommodation requirements. Fuel loads and aircraft performance factors are discussed with the flight engineers. The nav coordinates with CSOs to plan security requirements and communications needs. Water and ice requirements and en route food handling procedures are arranged through the APS. Although the mission is a team effort, the SAM navigator truly is the mission manager.

It's obvious that Det 1 navigators do things a little different from their counterparts in other units. Basic navigation requirements are met using all available navaids including celestial, INS, and radar. Grid navigation procedures are also practiced and used on annual "over the Pole" missions to Germany where CINCPACAF meets with the TAC commanders. However, the navigator's role exceeds that of the traditional Magellan. After departure, the challenge is to do everything possible to meet the scheduled arrival time. Knowing climb distance and time from the fuel planning manual and using a planned descent distance and time, it becomes a matter of determining the remaining distance available and deriving an appropriate mach number to make the necessary time work. Judgment and experience enable navs to factor in required time for taxiing, weather avoidance, traffic flow, etc. Usually this means arrival times are met within seconds of scheduled times. Standards are rigid within the parameters of safety, comfort and reliability. As in other units, Special Mission navigators get their share of no-notice evaluations but, more importantly, they are evaluated every time they fly by the success and satisfaction they bring their distinguished passengers.

With so much to learn and do, one might think that Det 1 navigators have little time for anything else. Wrong. Judging by the tans and golf scores it is readily apparent their job is not all work. One of the bonuses of Special Missions operations is that when VIPs stop for a few days to attend conferences or meet other commitments, the aircrew generally has leisure time (although they must respond if needed). Frequently, this means time for shopping or sightseeing in places like Seoul, Sydney, or Singapore. But after all, even when the mission is over, your're back--in Hawaii!

People often ask routine questions about flying time, TDY, etc. At the Detachment, flying time averages 300-400 hours a year and TDYs are normally seven to ten days per month. Remember, these are only averages. Trips range from overnight to three weeks and flying time can vary similarly. Many factors are beyond your control such as world events, budget restrictions, etc. Destinations also vary widely, but if you talk to enough people at the Detachment, you can find someone who has been almost anywhere you can name. Det missions are 70 percent to Pacific destinations, 25 percent to the CONUS (often to Andrews AFB), with the remaining 5 percent to the rest of the world.

One of the most notable features of Special Missions Pacific is the obvious confidence in the cockpit. Not to be confused with cockiness, there is a real atmosphere of professionalism due to experience. Each of the pilots has at least 3,000 hours of flying time and the flight engineers and CSOs have similar experience levels. Other crew members also have confidence in you, the navigator, knowing you have a minimum of 2,000 hours and at least instructor status.

Aside from seeing the world and working with generals and admirals, routine additional duties must be performed. After all, we're all competing for promotion. But knowing you'd be doing that anyway, doesn't this sound like a more interesting and challenging route to work your way up? Besides, it's a great method of earning credit for an overseas tour. You begin the process by submitting an AF Form 90. Then, who knows, next year you may be on the beach in Tahiti.

Maj Hamilton graduated from the USAF Academy in 1974 with a degree in Civil Engineering. After UNT, he was assigned to the C-141A at Charleston AFB. In 1979, he was reassigned to Andrews AFB before duty at Hickam AFB in 1982. Maj Hamilton currently serves at Mather AFB.

TERROR OVER THE NORTH ATLANTIC: A GROSS NAVIGATION ERROR

Lieutenant Colonel Jerald M. Davis, USAFR
HQ USAF/XOORF
The Pentagon

As I scanned the sky in one last futile attempt to locate Halley's comet just south of the constellation Pleiades, my mind drifted back to more earthly pursuits--the next week in Europe. In spite of the o'dark thirty departure, the hassle of finally locating a current North Atlantic organized track message at the Comm Center and the typically hectic mission planning and on-time departure, the flight settled down to another routine oceanic crossing with its accompanying sensations of suspended animation and solitude.

As I relaxed and absorbed the tranquility, I began to eagerly anticipate our arrival in Europe and started to mentally plan crew rest activities: fish, chips and bitters at Mildenhall's Bird-in-the-Hand; shopping in London; Sauerbraten and Zeller Schwartz Katz in Rhein Main; Veal Scallopini and vino in.... My solitude was sharply broken by a typically crisp British voice on 126.7. "Bozo 73, this is Shannon." My mind snapped back into the real world as I responded, "Go ahead, Shannon, this is Bozo 73." "Bozo 73, Shannon squawk 5327, ident." "5327 ident, Bozo 73." Even in this day of modern miracles such as the INS, it's still reassuring to hear a friendly voice on VHF indicating you've successfully completed another crossing, I thought as I tuned in the Shannon VOR. "Bozo 73, this is Shannon, you are radar identified 60 nm north of track. Are you having any difficulties?"

Sixty nm north of track! Am I having any difficulties? My mind raced as I frantically checked the INS. What's happening? What's the problem? Both "ready nav" green lights are on; both HSIs centered; autopilot engaged; no warning lights; both INS present positions indicate 53N, 15W; flight plan coordinates 53N, 15W. Everything looks OK as it has for the entire crossing. Nothing appears wrong; Shannon must be mistaken. We couldn't be off. "Bozo 73, Shannon."

"Shannon, Bozo 73, we show our position as 53N, 15W on both INSs which agrees with our flight plan." "Bozo 73, Shannon, your position is confirmed; however, we show your route of flight as 54N/30W, 53N/20W, 52N/15W, Shannon, instead of 53N/15W. Sir, please be advised that we'll have to file a gross navigation error report. You are in conflict with Air France flight #326 estimating 53N/15W at 0637 Zulu." "Roger, Bozo 73." "Bozo 73, Shannon, you are recleared 53N, 15W direct Shannon, flight plan route." "Roger, direct Shannon, flight plan route, Bozo 73."

Gross navigation error! 60 nm north! I'm really in trouble. I envisioned OPREP 3 messages, commanders, explanations, downgrades, investigations, retraining, requalification--No good times in Europe.

I still believed this couldn't be true as that uneasy, sinking feeling rushed up behind me. Now I was wide awake! As the adrenalin cleared the cobwebs, I frantically searched for the explanation, reconstructed the past few hours and went through my mental oceanic checklist. Oceanic clearance received on VHF from Gander, "Track Uniform, FL350, mach .78 for the crossing." Oceanic waypoint crosschecked: the copilot read the coordinates and I crosschecked the INS programming. INS waypoint crosschecks: since this was my leg, I had crosschecked the INS at each waypoint and both systems were normal. Radio INS switches; both switches were in INS and coupled to the autopilot. Track message: flight plan and INS programming crosschecked against the track message. All were OK. Whoa, wait a minute!

When the copilot read back the coordinates during the oceanic waypoint crosschecks, was he reading from the track message or from the flight plan. Bill's a sharp guy; it had to be the track message, right? "Hey, Bill, wake up!"

"What?" "Wake up!" "What's going on, Charlie?" "Bill, when you read back the coordinates for the oceanic waypoint checks, did you use the track message or the flight plan?" "The computer flight plan, I think. What's wrong?" That sinking feeling got worse as I said, "Shannon just told us that we're 60 nm north of course and they're filing a gross nav error. Let me see that track message." I again had visions of commanders, downgrades, hassles...

I grabbed the track message from Bill and quickly compared its coordinates with the flight plan. They were the same, weren't they? One more check to be sure. Oh, no! A second, slower scan found one subtle but fatal difference. The computer flight plan was 53N/20W, 53N/15W, SNN but the track was 53N/20W, 52N/15W, SNN. Finally, the brutal reality of the situation came sharply into focus. The controller was right! We were wrong! Our friendly flight planner had set a subtle trap for us and, in our rush during mission planning, we fell into that trap. Although we had checked the flight plan against the track message, we had missed this one critical difference. The controller was correct. We were having difficulties and these difficulties would certainly increase as soon as we landed. Good-bye good times!

IS THIS STORY REAL?

Although this story is fictitious, the USAF gross navigation error problem is *very* real. Unfortunately, this story is typical of most USAF North Atlantic gross navigation errors. Recent gross navigation errors involving USAF aircraft in the North Atlantic indicate a potentially serious degradation in navigation performance which could adversely impact the operational flexibility and efficiency necessary for mission accomplishment.

It is somewhat surprising that most gross navigation errors have at least two common factors; the navigation equipment functioned normally and the aircraft was navigated to the wrong place with precise knowledge of position. These errors are usually caused by an inadequate understanding of North Atlantic (NAT) minimum navigation performance specifications (MNPS) airspace operation and procedures or mismanaging the navigation and flight guidance systems.

HOW GROSS IS A GROSS NAVIGATION ERROR?

A "gross navigation error" is internationally defined as an unauthorized deviation of 25 nm or more from the exact centerline of the flight route assigned by ATC. Obtaining an ATC clearance is actually a negotiation process between the aircrew and the ATC controller. When the controller issues a clearance, ATC automatically agrees to provide you with the required separation (air traffic services) from all *known* IFR traffic. The primary air traffic service is the prevention of collision. When you accept an ATC clearance, you are agreeing to stay within the area assigned by ATC. This principle is of paramount importance in oceanic areas since ATC does not have independent knowledge of your actual position and must depend entirely on position reports to identify potential conflicts. In NAT/MNPS airspace, the ATC lateral separation minima is 60 nm. Thus by accepting an ATC clearance, you have agreed to remain within $\pm$ 30 nm of the exact centerline of your assigned route of flight. A navigation error of 30 nm or more means you have deviated from your "protected" airspace, blundered into another aircraft's "protected" airspace, and become a collision hazard to yourself and others.

WHAT IS NAT/MNPS?

The MNPS concept was adopted by the International Civil Aviation Organization (ICAO) following its endorsement in 1976 by ICAO's 9th Air Navigation Council. In adopting this concept, ICAO stipulated two basic guidelines for establishing MNPS: a safety need must be clearly identified and economic benefits must be provided to most users of this airspace. Accepting the MNPS concept represented a major philosophical change in ICAO's approach to Standards and Recommended Practices for navigation systems and ATC separation minima. The MNPS concept specifies the required overall navigation performance, including the aircrew's ability to use the systems, instead of specifying equipment accuracy requirements or requiring specific navigation systems.

WHERE IS NAT/MNPS AIRSPACE?

This airspace is defined as the North Atlantic oceanic airspace between FL275 and FL400, between the latitudes of 27 degrees north and the North Pole. NAT/MNPS airspace boundaries are depicted on North Atlantic IFR Enroute Charts (U.S. H 3 and H 4, and Canadian HE1, HE4, LE10). The best NAT/MNPS depiction is on the Canadian LE10 IFR enroute chart.

INCOMPREHENSIBLE MATHEMATICIAN'S "FLUTE MUSIC" MADE SEMIUNDER - STANDABLE

Mathematical collision risk methodology (CRM) is inherent in the MNPS concept. The CRM is based on an internationally agreed target level of safety (TLS) which represents the probability of a mid-air collision due to inadequate navigation performance. To under - stand collision risk methodology, you must understand navigation performance. In the MNPS concept, navigation performance can be thought of as any deviation from the exact centerline of the route of flight specified in the current ATC clearance. Navigation performance includes errors due to: (1) position errors inherent in the navigation system (accuracy), (2) navigation equipment malfunction/failure (reliability), (3) misunderstandings between the crew and ATC concerning the route to be flown, and (4) misunderstandings between ATC units concerning the assigned route of flight. In other words, navigation performance is the overall performance of the ATC system. Since controlling collision risk is fundamental to MNPS and flight safety, any error which could cause a mid-air collision must be analyzed and controlled.

Since flight safety in the NAT depends on continuously maintaining the required navigation performance, radar observation windows have been established in Eastern Canada, Western United Kingdom, Ireland, and Western France to detect aircraft with inadequate course keeping ability. During the 1 Mar 84 to 28 Feb 85 reporting period, approximately 102,000 aircraft were radar observed exiting oceanic airspace at these windows. About 12,000 of these aircraft were military. Any aircraft radar-observed to be 30 nm or more from the exact centerline of the assigned route is reported to the State of Registry as a gross navigation error. This report includes a request for investigation to determine the cause of the error. For 10,000 observations (approximate number of USAF operations), the MNPS criteria allow 5 errors of 30 nm or more and only one error which is within 10 nm of a multiple of the separation standard (50-70 nm, 110-130, etc). During this same reporting period, the USAF had 6 errors. Since 1 Mar 85, the USAF committed 13 errors of 30 nm or more and 7 separation standard errors which has concerned the international community, the DOD, and ICAO states monitoring flight safety in the North Atlantic.

WHAT THE MATHEMATICIANS "FLUTE MUSIC" MEANS TO YOU

Your navigation performance in NAT/MNPS airspace is an open book for the international community. Your flight will be radar monitored as you exit oceanic airspace and your position-keeping error will be recorded. If you are as unfortunate as Charlie and Bill and exit oceanic airspace at a radar observation window 30 nm or more from the exact centerline of your assigned route of flight, a formal gross navigation error report will be forwarded to your unit for investigation. These reports attract a lot of attention in high places and are a sure way to "blow" your low profile.

The NAT/MNPS criteria are extraordinarily demanding when you personalize them. They mean that each crew member cannot make more than one mistake in 1,887 oceanic crossings (15,000 flying hours) which would result in an error of 30 nm or more; or one mistake in 7,693 oceanic crossings (61,000 flying hours) which would result in a separation standard error (50-70 nm, 110-130 nm, etc). From this, it should be painfully obvious that we are not permitted even one mistake of these magnitudes in our entire flying career!

ROOT CAUSES OF USAF GROSS NAVIGATION ERRORS

During the early days of NAT/MNPS, the USAF fleet transitioned from manual navigation (using Doppler, Loran, pressure pattern, celestial, and dead reckoning) to automatic electronic long range navigation systems such as INS and OMEGA. This transition significantly improved the navigation accuracy and reliability. However, as a result of this transition, the character of the USAF gross navigation errors changed from random errors due to position uncertainty to

precisely navigating to the wrong place due to misunderstandings or mismanagement of the automated systems. Although the number of USAF formal navigation errors decreased following this transition, the current error rate exceeds the MNPS maximum allowable rates.

The fact that the gross error rate currently exceeds the maximum allowed by MNPS--after USAF aircraft were equipped with navigation equipment capable of meeting the MNPS--suggests latent unresolved operational problems. Reviewing these errors reveals two common and somewhat surprising factors: the navigation equipment functioned normally (no equipment failures), and the aircraft was navigated with precise knowledge of position to the wrong place. Although occurring more infrequently, these two factors are also common to civil aviation gross errors. Some of the significant factors contributing to USAF gross errors are:

a. Inadequate understanding of the ATC clearance (flew flight plan route).

b. Operational procedures not compatible with MNPS operation (autopilot not coupled to the INS/OMEGA, flying headings provided by the navigator).

c. Inadequate mission planning (failure to adequately cross check flight plan against track message).

d. Inadequate crew coordination (ATC clearance not common knowledge in the cockpit).

e. Inadequate operating procedures for cross checking navigation equipment (incorrect waypoint programmed.)

f. Inadequate cockpit documentation (track message not available to the crew or computer flight plan not compatible with NAT/OTS structure).

g. Inadequate understanding of MNPS operational requirements (not obtaining oceanic clearance prior to entry).

Further analysis of USAF errors shows two relatively distinct groups. In one group the navigation equipment is operating properly with an incorrect waypoint or route of flight programmed by the flight crew. In the other group, the navigation equipment is properly programmed but is not used as the primary steering reference; the aircraft is flying headings while the navigator practices manual navigation.

Experience has shown that manual navigation cannot meet MNPS requirements. Thus, MNPS and automated equipment were created. Additionally, international groups generally agree that manually steering the INS/OMEGA is inadequate to meet the MNPS, especially if the cross track information is not presented to the pilots on the HSI/CDI so the pilots must fly headings provided by the navigator. It is also generally agreed internationally that Doppler systems require constant attention to in-flight rating and compensation for systematic errors and that future installation of Doppler cannot be recommended for unrestricted MNPS operation. USAF operations with Doppler generally do not diligently apply the sophisticated compensation techniques necessary to achieve the precision required by MNPS (mean error no greater than 6.3 nm). Although a single INS or OMEGA combined with a navigator may have the accuracy necessary to meet MNPS, the operational procedures applied to their use do not meet the overall MNPS performance requirements.

Civil operators have already learned the hard way that airborne navigation equipment, training programs, operational procedures, preflight activities, guidance and regulatory material and their operational control system must be specifically tailored for MNPS operation to reduce the occurrence of errors. Resolving these types of errors involves enhancing understanding and appreciation of the unique aspects of NAT/MNPS operation by aircrews and support personnel alike.

"IT'LL NEVER HAPPEN TO ME"

We all have a tendency to think it can't happen to us. "We're more professional than that." Experience shows there are those who have and those who will. History in the North Atlantic clearly proves that even the most experienced crews are involved in gross navigation errors. Also there is some evidence that highly experienced civil crews make these mistakes more frequently than civil crews new to the NAT. It could be that familiarity breeds complacency since many of the errors have subtle causes where a moment's inattention sets the trap.

WHAT IS THE BOTTOM LINE?

The most significant thing to remember is that safety of flight in the North Atlantic is totally dependent on your performance and professionalism. The system is only as safe as you are, and you can make it unsafe for everyone else!

STAR IDENTIFICATION

Editor's Note: Various squadrons and individuals continually request reprint rights for this popular article which last appeared in the 1981-82 issues. The author, Lt Col Peter A. Cook, retired from the Air Force last February. Presently employed by McDonnell Douglas Helicopter Co., he is in charge of application software for helicopter simulators. So that all of you might benefit from these diagrams, we are printing this multi-part article.

In order to take an accurate star shot, it is first necessary to shoot the *correct* star. When using a periscopic sextant, the best way to identify the *correct* star is by recognizing the unique "pattern" formed by the stars in the sextant's field of view. In this regard, the star groups that are usually learned, such as the "Navigator's Triangle", the "Arc of Capella", and the "Baseball Diamond", are too large for easy recognition in the narrow field of vision afforded by most sextants.

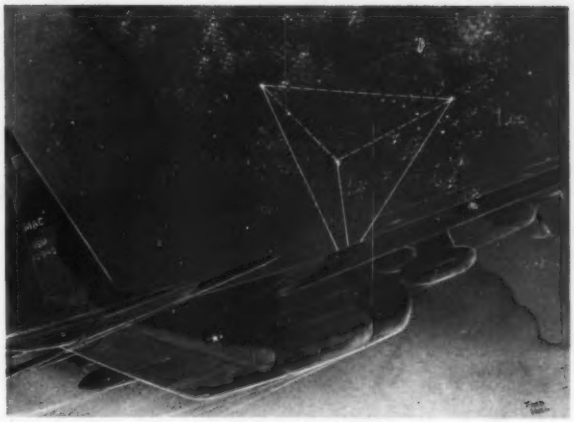
The charts presented in this article show the field-of-view patterns for Polaris and all the stars listed in HO 249, Volume I. By using these charts and their accompanying tables, the observer can predict exactly what he will see when looking for a particular star.

Each chart shows the 1st, 2nd, 3rd, and 4th magnitude stars that are visible with a sextant with a 15° field of view when the desired star is in the center. On a clear night many more will be visible; on a hazy or moonlit night only the brightest will show. Lines were included to make the patterns more meaningful. Most of these follow the lines of the better known constellations.

The stars are shown as they would appear from the North Pole. For other latitudes, the accompanying tables of position angles tell how much the charts should be rotated to give the correct presentation for the time of the observation. Dashes indicate that the star is below the horizon at those points.

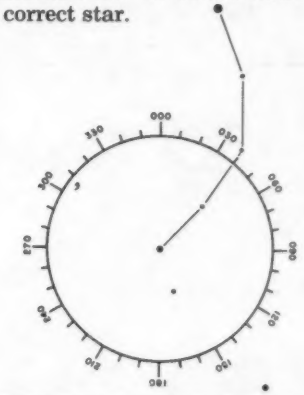
To use the charts, enter the table with the closest values of latitude and LHA of Aries to find the position angle. Then rotate the chart until this position angle is at the top. The star pattern which results is the one which will appear in the sextant.

As an example, say you want to shoot Polaris. Your latitude is 42° N and your precomp sheet shows the LHA of Aries to be 159. Entering the Polaris table with the nearest values of latitude and LHA (40° N and 150) you find the position angle to be 302. Though interpolation can be used for greater accuracy, it is not usually necessary.



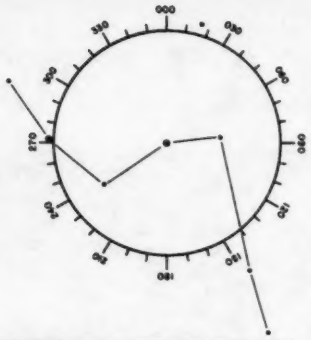
Then take the Polaris chart and turn it until 302 is at the top. In this position, the handle of the "Little Dipper" will stretch out to the right. Now turn the sextant to the precomputed bearing and altitude and look for this pattern. When you see the handle of the dipper leading off to the right, you can easily locate Polaris and will be certain that you are shooting the correct star.

POLARIS



LHA Aries / Lat	0	30	60	90	120	150	180	210	240	270	300	330
80N	143	180	217	251	281	309	335	000	025	051	079	109
70N	147	180	213	245	276	305	333	000	027	055	084	115
60N	148	180	212	243	274	303	332	000	028	057	086	117
50N	149	180	211	242	273	302	331	000	029	058	087	118
40N	149	180	211	242	272	302	331	000	029	058	088	118
30N	149	180	211	242	271	300	331	000	029	060	089	118
20N	149	180	211	240	270	300	331	000	029	060	090	120
10N	149	180	211	240	270	300	331	000	029	060	090	120
0	149	180	211	240	270	300	329	000	031	060	090	120
10S	-	-	-	-	-	-	-	-	-	-	-	-
20S	-	-	-	-	-	-	-	-	-	-	-	-
30S	-	-	-	-	-	-	-	-	-	-	-	-
40S	-	-	-	-	-	-	-	-	-	-	-	-
50S	-	-	-	-	-	-	-	-	-	-	-	-
60S	-	-	-	-	-	-	-	-	-	-	-	-
70S	-	-	-	-	-	-	-	-	-	-	-	-
80S	-	-	-	-	-	-	-	-	-	-	-	-

ACAMAR

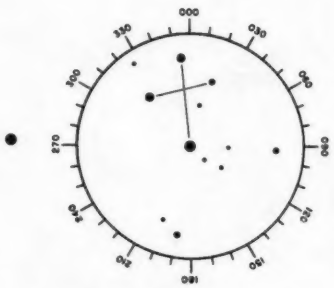


LHA Y / LAT	0	30	60	90	120	150	180	210	240	270	300	330
80N	-	-	-	-	-	-	-	-	-	-	-	-
70N	-	-	-	-	-	-	-	-	-	-	-	-
60N	-	-	-	-	-	-	-	-	-	-	-	-
50N	-	-	-	-	-	-	-	-	-	-	-	-
40N	032	011	348	327	-	-	-	-	-	-	-	-
30N	037	013	345	321	-	-	-	-	-	-	-	-
20N	044	015	343	320	-	-	-	-	-	-	-	-
10N	050	018	340	309	286	-	-	-	-	-	-	072
0	056	022	336	302	279	-	-	-	-	-	-	079
10S	065	026	330	293	271	-	-	-	-	-	-	087
20S	076	035	321	283	262	245	-	-	-	-	114	096
30S	088	053	302	270	254	238	-	-	-	-	121	105
40S	105	095	265	255	243	230	-	-	-	147	129	114
50S	123	140	223	237	232	222	207	189	170	152	138	127
60S	141	161	201	220	220	212	201	187	172	158	147	140
70S	157	171	190	203	206	203	195	185	175	164	156	154
80S	169	176	185	191	193	192	189	183	176	171	168	167

ACHERNAR

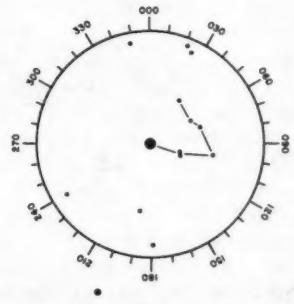
LHA Y / LAT	0	30	60	90	120	150	180	210	240	270	300	330
80N	-	-	-	-	-	-	-	-	-	-	-	-
70N	-	-	-	-	-	-	-	-	-	-	-	-
60N	-	-	-	-	-	-	-	-	-	-	-	-
50N	-	-	-	-	-	-	-	-	-	-	-	-
40N	-	-	-	-	-	-	-	-	-	-	-	-
30N	-	355	-	-	-	-	-	-	-	-	-	-
20N	023	354	326	301	-	-	-	-	-	-	-	-
10N	025	354	323	295	-	-	-	-	-	-	-	054
0	028	353	320	290	-	-	-	-	-	-	085	059
10S	030	352	315	285	260	-	-	-	-	-	090	063
20S	035	351	310	280	255	229	-	-	-	121	096	070
30S	041	349	303	272	249	225	201	-	150	126	103	077
40S	051	346	292	264	242	221	199	175	153	131	110	086
50S	071	334	275	252	234	215	196	176	157	137	118	099
60S	109	234	248	238	224	210	194	177	160	144	130	118
70S	149	189	218	220	213	202	190	178	164	153	144	140
80S	169	183	194	199	197	193	187	179	171	165	162	162

ACRUX



LHA Y / LAT	0	30	60	90	120	150	180	210	240	270	300	330
80N	-	-	-	-	-	-	-	-	-	-	-	-
70N	-	-	-	-	-	-	-	-	-	-	-	-
60N	-	-	-	-	-	-	-	-	-	-	-	-
50N	-	-	-	-	-	-	-	-	-	-	-	-
40N	-	-	-	-	-	-	-	-	-	-	-	-
30N	-	-	-	-	-	-	-	-	-	-	-	-
20N	-	-	-	-	-	034	005	337	-	-	-	-
10N	-	-	-	-	064	036	007	335	307	-	-	-
0	-	-	-	-	068	039	007	334	303	276	-	-
10S	-	-	-	100	073	043	008	331	299	271	-	-
20S	-	-	130	105	079	047	008	328	293	266	240	-
30S	185	159	135	110	085	053	010	323	287	260	235	210
40S	185	161	138	116	092	061	012	315	279	254	230	208
50S	184	164	143	123	102	075	019	301	267	245	225	204
60S	183	166	149	132	120	100	059	269	250	234	218	201
70S	182	169	156	144	136	135	166	220	226	219	209	197
80S	182	173	166	160	158	163	177	192	201	201	197	190

ALDEBARAN



LHA Y / LAT	0	30	60	90	120	150	180	210	240	270	300	330
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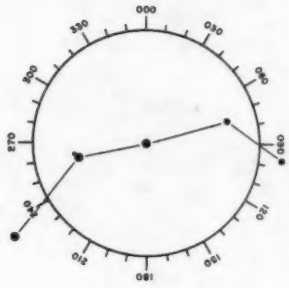
70N	020	014	003	351	342	340	342	348	-	-	016	021
60N	031	023	005	345	332	329	333	-	-	-	-	031
50N	042	033	009	337	322	318	-	-	-	-	-	040
40N	053	047	015	325	309	308	-	-	-	-	-	049
30N	064	061	026	308	296	298	-	-	-	-	-	059
20N	075	078	061	284	283	287	-	-	-	-	-	-
10N	086	095	127	258	270	277	-	-	-	-	-	-
0	097	109	153	236	258	268	-	-	-	-	-	-
10S	106	122	163	222	247	258	-	-	-	-	-	-
20S	116	133	167	212	237	248	-	-	-	-	-	-
30S	125	142	171	205	227	-	-	-	-	-	-	-
40S	134	149	173	199	218	-	-	-	-	-	-	-
50S	144	156	174	195	211	-	-	-	-	-	-	-
60S	-	162	176	191	203	-	-	-	-	-	-	-
70S	-	168	177	187	-	-	-	-	-	-	-	-
80S	-	-	-	-	-	-	-	-	-	-	-	-

ALIOTH



LHAT / LAT	0	30	60	90	120	150	180	210	240	270	300	330
80N	357	004	011	016	018	015	005	354	345	342	345	350
70N	354	007	018	029	036	036	019	339	323	324	331	342
60N	352	008	025	040	052	062	056	302	299	309	321	337
50N	350	011	030	048	066	084	119	244	277	296	313	331
40N	350	013	034	055	076	100	132	220	262	285	306	327
30N	-	-	038	062	084	111	153	211	251	278	300	323
20N	-	-	-	067	091	119	158	205	242	270	295	-
10N	-	-	-	073	098	126	161	202	236	264	289	-
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10S	-	-	-	-	109	135	165	197	227	-	-	-
20S	-	-	-	-	-	139	166	195	222	-	-	-
30S	-	-	-	-	-	-	168	193	-	-	-	-
40S	-	-	-	-	-	-	-	-	-	-	-	-
50S	-	-	-	-	-	-	-	-	-	-	-	-
60S	-	-	-	-	-	-	-	-	-	-	-	-
70S	-	-	-	-	-	-	-	-	-	-	-	-
80S	-	-	-	-	-	-	-	-	-	-	-	-

ALKAID

LHAT / LAT	0	30	60	90	120	150	180	210	240	270	300	330
80N	355	001	007	013	016	014	009	359	349	344	345	348
70N	350	001	013	023	031	032	023	356	334	328	331	339
60N	346	002	017	032	044	050	046	348	310	311	319	332
50N	343	003	022	039	054	068	080	271	283	296	309	325
40N	340	003	025	045	064	082	109	197	260	283	300	319
30N	-	-	-	052	073	094	125	190	244	272	293	314
20N	-	-	-	057	080	103	136	187	234	263	286	-
10N	-	-	-	-	087	111	143	186	227	256	280	-
0	-	-	-	-	093	117	148	185	221	249	-	-
10S	-	-	-	-	-	123	152	185	217	244	-	-
20S	-	-	-	-	-	128	155	184	213	237	-	-
30S	-	-	-	-	-	-	158	183	209	-	-	-
40S	-	-	-	-	-	-	-	-	-	-	-	-
50S	-	-	-	-	-	-	-	-	-	-	-	-
60S	-	-	-	-	-	-	-	-	-	-	-	-
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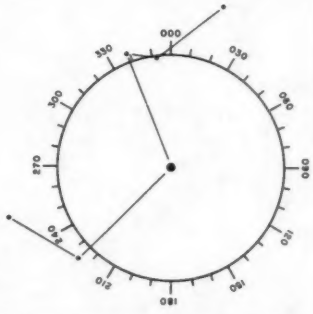
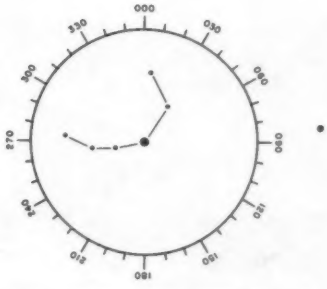
ALPHARD



LHAT / LAT	0	30	60	90	120	150	180	210	240	270	300	330
80N	-	-	-	-	004	358	354	-	-	-	-	-
70N	-	-	-	016	008	358	348	341	-	-	-	-
60N	-	-	-	024	011	356	341	333	-	-	-	-
50N	-	-	-	032	016	354	334	323	-	-	-	-
40N	-	-	049	041	022	352	327	314	-	-	-	-
30N	-	-	059	050	027	349	318	304	-	-	-	-
20N	-	-	069	060	038	344	307	294	-	-	-	-
10N	-	-	079	072	051	336	294	284	-	-	-	-
0	-	-	088	084	071	315	280	273	-	-	-	-
10S	-	-	099	096	097	255	264	262	-	-	-	-
20S	-	-	109	109	122	212	248	252	-	-	-	-
30S	-	-	119	121	140	198	233	240	-	-	-	-
40S	-	-	129	134	152	191	221	230	-	-	-	-
50S	-	-	139	144	161	188	210	220	219	-	-	-
60S	-	-	149	154	167	186	201	209	209	-	-	-
70S	-	161	160	164	172	183	193	200	200	-	-	-
80S	174	171	170	172	176	182	187	190	190	188	-	-

ALPHECCA



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70S	-	-	-	-	-	-	-	-	-	-	-	-
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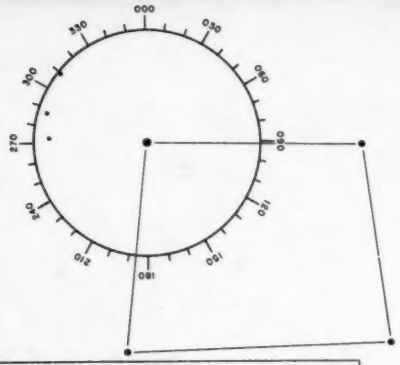

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ALTAIR

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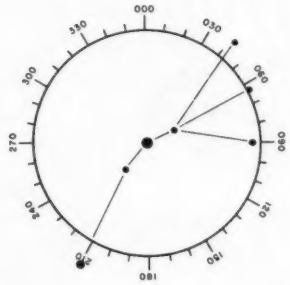

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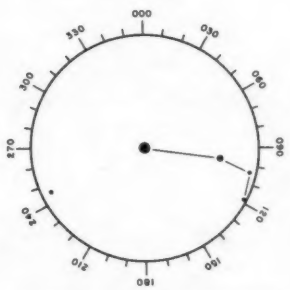
ARCTURUS



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70S	-	-	-	-	-	-	-	178	-	-	-	-
80S	-	-	-	-	-	-	-	-	-	-	-	-

BETELGEUSE

LHAT / LAT	0	30	60	90	120	150	180	210	240	270	300	330
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70S	-	163	170	180	190	197	-	-	-	-	-	-
80S	-	-	176	180	185	-	-	-	-	-	-	-

CANOPUS

LHAT / LAT	0	30	60	90	120	150	180	210	240	270	300	330
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70N	-	-	-	-	-	-	-	-	-	-	-	-
60N	-	-	-	-	-	-	-	-	-	-	-	-
50N	-	-	-	-	-	-	-	-	-	-	-	-
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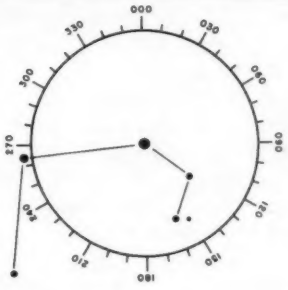
CAPELLA



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40S	-	-	166	189	-	-	-	-	-	-	-	-
50S	-	-	-	-	-	-	-	-	-	-	-	-
60S	-	-	-	-	-	-	-	-	-	-	-	-
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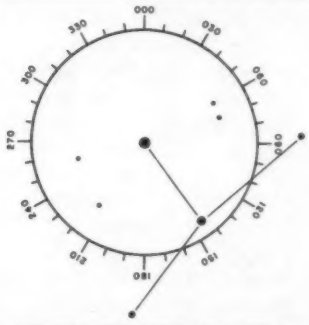

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40S	-	-	-	-	-	-	-	-	-	-	173	195
50S	-	-	-	-	-	-	-	-	-	-	-	-
60S	-	-	-	-	-	-	-	-	-	-	-	-
70S	-	-	-	-	-	-	-	-	-	-	-	-
80S	-	-	-	-	-	-	-	-	-	-	-	-

Professional Reading

Major Donald W. RIGHTMYER
HQ TAC/SEP
Langley AFB, VA

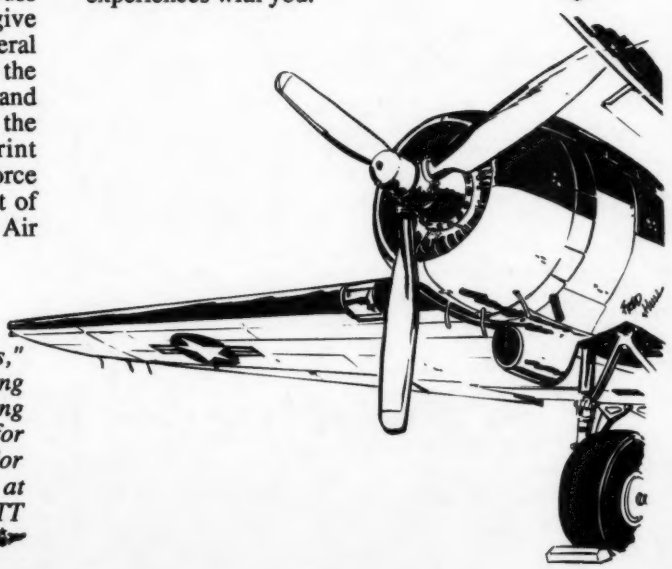
World War II was the acid test for the first experiments in military air power that had begun during the First World War. The interwar years saw extensive doctrinal and airframe developments which were finally brought into action when war broke out in 1939. While a great struggle was being fought between Axis and Allied armies on the continents of Europe, Asia and North Africa, an equally great decision was being contested in the air. The result was a watershed in the development and understanding of air power's many uses, both in peacetime and in war.

While the literature of the war is nearly as massive as the forces that fought it, here are a few titles on our Air Force's part in it that will help you in beginning your own personal study. The most comprehensive history yet written on the air war is the seven-volume *The Army Air Forces in World War II*. Edited by Wesley Craven and James Cate, this series was written in the immediate postwar years by numerous historians and observers who were on the scene during the air battles. The multi-volume collection begins by surveying the early years of air power's development leading up to the outbreak of war. Volumes 2 and 3 cover the U.S. Army Air Forces' (AAF) participation in the European theater while volumes 4 and 5 discuss the pacific air war. The final two volumes give an in-depth look at the men, planes and general global operations conducted in support of the AAF such as weather, runway construction, and aircraft ferrying. "Craven and Cate," as the series is commonly called, went out of print several years ago but the Office of Air Force History recently reprinted the series as part of Project Warrior. You will find this in every Air Force base library.

The Air War, 1939-1945, by R.J. Overy, casts the AAF's role into a larger context with the other air forces involved in the war. Besides the European and Far East air campaigns, the author covers several important areas including the various combatants' aircraft industries, leadership, training and the roles of science and intelligence in fighting the war.

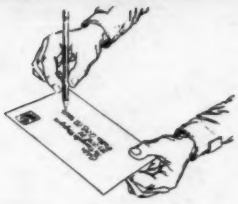
A thoroughly interesting account of our World War II air leadership is Gen. "Hap" Arnold's *Global Mission*. Arnold's story is based on his personal experiences and the diary he kept during the war years. Hopefully your library has a copy because the book has been out of print for several years. Gen. William H. Tunner's *Over the Hump*, however, has just been reprinted. Tunner's autobiography begins with his early experiences in aircraft ferry operations and then flying the Hump to resupply Allied forces in Asia. The latter chapters also cover his leadership during the Berlin Airlift, Korea and the early years of MAC (then MATS).

These are just a few of the numerous books that have been written to document the greatest air war ever fought. Pick up one for your summertime reading and then take advantage of the countless veterans of the air campaigns that are still around to share their insights and experiences with you.



ERRATUM

The article titled "Airdropping Navy Seals," printed in the Spring 1986 issue, erred in stating that Joint Airborne/Air Transportability Training (JA/ATT) missions are funded by the user (for example, the Army or Navy). According to Major Pete Nelson of the Airlift Operations School at Scott AFB, IL, the units flying the JA/ATT missions fund them.



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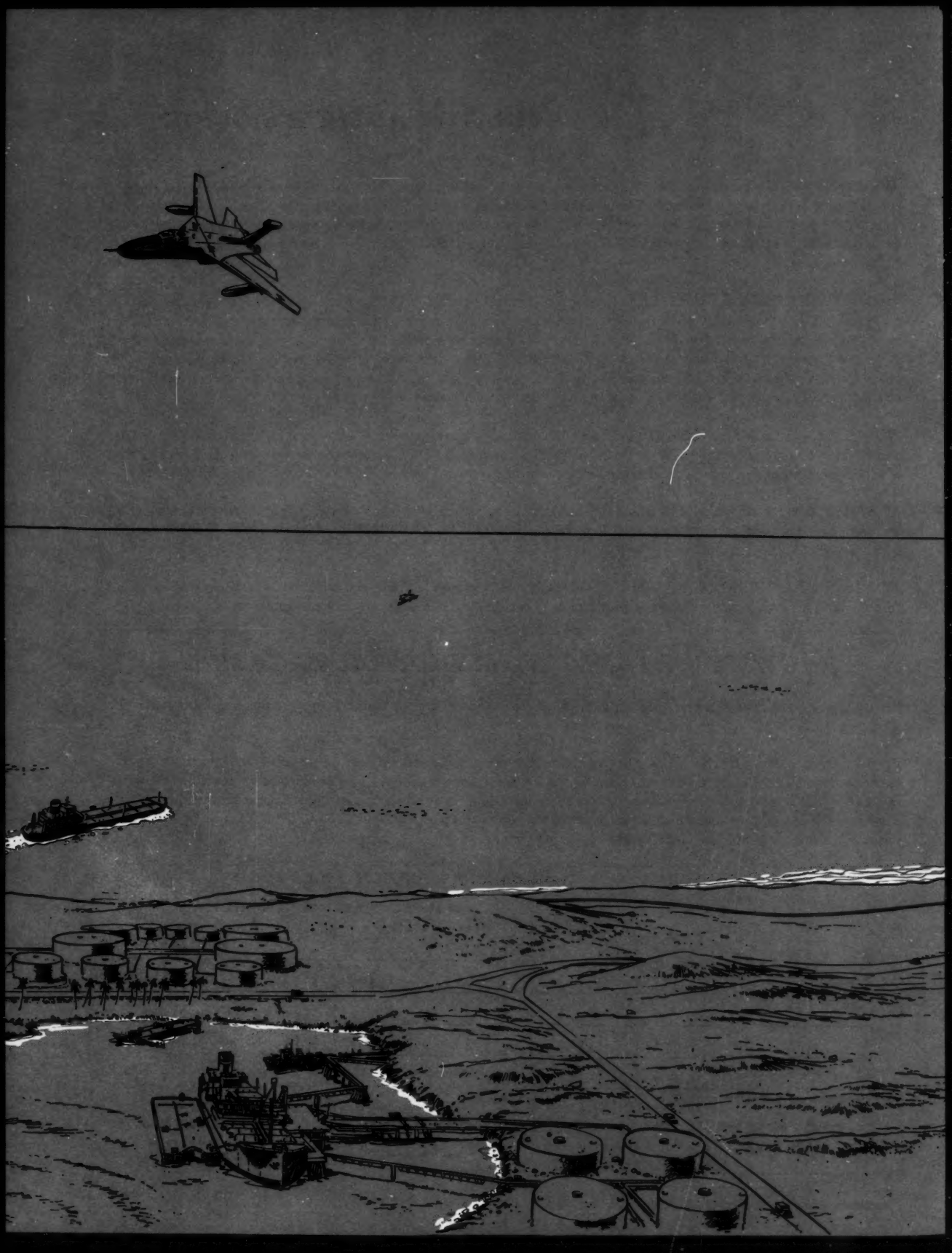
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